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[Title of the Invention] METHOD OF MANUFACTURING LIQUID CRYSTAL DESPLAY DEVICE AND APPARATUS FOR MANUFACTURING LIQUID CRYSTAL DISPLAY DEVICE

[Abstract]

[Object] To provide a method of manufacturing a liquid crystal display device using a droplet injection method in which liquid crystal is dropped on one transparent panel in a decompressed atmosphere, the other transparent panel is overlapped thereon, and then the dropped liquid crystal is sealed, so as to suppress decrease in voltage holding rate with a rough positioning accuracy and a uniform gap between the panels.

[Construction] The method comprises the steps of: forming an adhesive member 2 in a ring shape outside a display area on a first transparent panel 1; selectively irradiating ultraviolet rays onto the inner circumferential surface of the ring-shaped adhesive member 2 and curing the irradiated area; dropping liquid crystal 3 on the first transparent panel 1 surrounded with the adhesive member 2; overlapping the first transparent panel 1 and a second transparent panel 4 in a decompressed atmosphere and sealing a space surrounded with the adhesive member 2 between the first transparent panel 1 and the second transparent panel 4 with

the adhesive member 2; and irradiating the ultraviolet rays onto the entire adhesive member 2 and curing the adhesive member.

[Claims]

[Claim 1] A method of manufacturing a liquid crystal display device, the method comprising the steps of:

forming an adhesive member in a ring shape outside a display area on a first transparent panel;

selectively irradiating ultraviolet rays onto the inner circumferential surface of the ring-shaped adhesive member and curing the irradiated area;

dropping liquid crystal on the first transparent panel surrounded with the adhesive member;

overlapping the first transparent panel and a second transparent panel with spacers therebetween in a decompressed atmosphere and sealing a space surrounded with the adhesive member between the first transparent panel and the second transparent panel with the adhesive member; and

positioning the first transparent panel and the second transparent panel, irradiating the ultraviolet rays onto the entire adhesive member, and curing the adhesive member.

[Claim 2] A method of manufacturing a liquid crystal display device, the method comprising the steps of:

forming a first adhesive member in a ring shape outside

a display area on a first transparent panel;

forming a second adhesive member in a ring shape outside the display area on a second transparent panel to correspond to the area where the first adhesive member;

irradiating ultraviolet rays onto the first adhesive member and the second adhesive member and curing the surface layers thereof;

dropping liquid crystal on the first transparent panel surrounded with the first adhesive member;

overlapping the first transparent panel and the second transparent panel in a decompressed atmosphere and sealing a space surrounded with the first adhesive member and the second adhesive member between the first transparent panel and the second transparent panel with the adhesive members; and

positioning the first transparent panel and the second transparent panel, irradiating the ultraviolet rays onto the first and second adhesive members, and curing the adhesive member, thereby fixing the first transparent panel and the second transparent panel.

[Claim 3] A method of manufacturing a liquid crystal display device, the method comprising the steps of:

forming an adhesive member in a ring shape outside a display area on a first transparent panel;

a dropping liquid crystal on the first transparent

panel surrounded with the adhesive member;

overlapping the first transparent panel and a second transparent panel with spacers therebetween in a decompressed atmosphere and sealing a space surrounded with the adhesive member between the first transparent panel and the second transparent panel with the adhesive member; and

irradiating the ultraviolet rays onto the entire adhesive member and curing the adhesive member after positioning the first transparent panel and the second transparent panel and before the adhesive member comes in contact with the liquid crystal.

[Claim 4] The method of manufacturing a liquid crystal display device according to any one of Claims 1 to 3, wherein color filters or liquid crystal driving matrixes are formed in the display area on the first transparent panel and liquid crystal driving matrixes or color filters are formed in the display area on the second transparent panel.

[Claim 5] The method of manufacturing a liquid crystal display device according to Claim 3 or 4, wherein a convex portion for reducing the diffusion speed of the liquid crystal is formed outside the display area on the first or second transparent panel and inside the area where the adhesive member is formed.

[Claim 6] The method of manufacturing a liquid crystal display device according to Claim 5, wherein The convex

portion for reducing the diffusion speed of the liquid crystal is made of the same material as the color filters formed in the display area of the first or second transparent panel.

[Claim 7] The method of manufacturing a liquid crystal display device according to any one of Claims 1 to 6, wherein a film for capturing moving ions is formed on the first or second transparent panel inside and adjacent to the area where the adhesive member is formed.

[Claim 8] The method of manufacturing a liquid crystal display device according to any one of Claims 1 to 7, wherein the first transparent panel and the second transparent panel are overlapped with each other by inserting a spacer plate inserted between the first transparent panel and the second transparent panel such that a part of the first transparent panel and a part of the second transparent panel are in contact with each other and then removing the spacer plate and the gap therebetween is sealed.

[Claim 9] The method of manufacturing a liquid crystal display device according to any one of Claims 1 to 7, wherein the first transparent panel has a plurality of holes or cut-out portions outside the ring-shaped adhesive member and the second transparent panel is overlapped with the first transparent panel by inserting support members into

the holes or cut-out portions of the first transparent panel, laying the second transparent panel on the support members, and then descending the support members.

[Claim 10] The method of manufacturing a liquid crystal display device according to any one of Claims 1 to 9, wherein preliminary color filters are formed around the display area on the first or second transparent panel in accordance with the arrangement order of the color filters in the display area.

[Claim 11] An apparatus for manufacturing a liquid crystal display device, the apparatus comprising:

a process chamber in which a first transparent panel and a second transparent panel are overlapped with each other; and

a gas introduction port which is disposed to face the first or second transparent panel laid in the process chamber and which sprays gas to the first or second transparent panel to press the panel.

[Claim 12] The apparatus for manufacturing a liquid crystal display device according to Claim 11, wherein the gas introduction port is a leak port for restoring the inner pressure of the process chamber to the atmospheric pressure.

[Detailed Description of the Invention]

[0001]

[Industrial Applicability]

The present invention relates to a method of manufacturing a liquid crystal display device and an apparatus for manufacturing a liquid crystal display device, and more particularly to improvement of a so-called dropping injection method in which liquid crystal is dropped on a transparent panel in a decompressed atmosphere, another transparent panel is overlapped thereon, and then the liquid crystal is sealed.

[0002]

[Description of the Related Art]

A vacuum sealing method requires much time for sealing liquid crystal in a liquid crystal display panel, but the development of a dropping injection method makes it possible to greatly reduce the time for sealing liquid crystal, which has been paid attention to. A conventional dropping injection method is now described with reference to the drawings. Fig. 22(a) is a cross-sectional view taken along Line G-G of Fig. 22(b).

[0003]

First, in step P1 of the flowchart shown in Fig. 19, members required for forming a liquid crystal display panel are formed on a transparent panel made of glass or the like. That is, two transparent panels are prepared for a liquid crystal display panel, thin film transistors (TFT), drain

bus lines, gate bus lines, pixel electrodes, and the like are formed on transparent panel and an alignment film is formed thereon, thereby forming a TFT panel. Color filters of R (red), G (green), and B (blue) are formed on the other transparent panel, a counter electrode made of a transparent ITO (Indium Tin Oxide) film is formed thereon, and an alignment film is formed thereon, thereby forming a color filter panel (hereinafter, referred to as "CF panel").

[0004]

Next, in step P2, the alignment films formed on the TFT panel and the CF panel are subjected to a rubbing process. Next, in step P3, spacers are scattered on the TFT panel. This is to secure a gap for filling liquid crystal between the TFT panel and the CF panel. On the other hand, in step P4, ultraviolet-curing sealing member is formed on the surface of the CF panel to surround a rectangular area for enclosing the liquid crystal.

[0005]

Next, in step P5, the liquid crystal is dropped in the area surrounded with the sealing member on the CF panel. In step P6, the TFT panel and the CF panel are introduced into a bonding apparatus shown in Fig. 20 and the apparatus is exhausted in vacuum. In step P7, the rough positioning of the TFT panel and the CF panel is performed. This step is a process of positioning and overlapping the TFT panel and the

CF panel in a decompressed atmosphere to some extent and weakly pressing them. The liquid crystal is sealed with the sealing member 32 in the space between the TFT panel and the CF panel.

[0006]

In this step, the CF panel 31 on which the sealing member 32 is formed and the liquid crystal 33 is dropped is mounted on a stage ST in the apparatus shown in Fig. 20. On the other hand, the TFT panel 34 is introduced into the apparatus shown in Fig. 20 and is supported by support members SU as shown in Fig. 21(a). The exhaust valve 42 of Fig. 20 is opened and the apparatus is exhausted into vacuum through an exhaust port 41, whereby a process chamber 40 of the apparatus is decompressed. Next, as shown in Fig. 21(a), the TFT panel 34 is disposed to be opposed to the CF panel 33 and then is dropped onto the CF panel 31 as shown in Fig. 21(b). Thereafter, the TFT panel 34 is pressed from the upside with a pressing member 43 shown in Fig. 20.

[0007]

Next, in step P8, the transparent panels roughly positioned are taken out and are precisely positioned such that the display area of the TFT panel 34 and the display area of the CF panel 33 correspond to each other. This step allows the dropped liquid crystal 33 to uniformly diffuse on the entire surface surrounded with the sealing member 32 as

shown in Figs. 22(a) and 22(b). Thereafter, in step P9, ultraviolet rays are irradiated to the sealing member 32 to completely cur it and the TFT panel 34 and the CF panel 31 are fixed, thereby forming the liquid crystal display panel in which the liquid crystal is sealed.

[0008]

[Problems to be Solved by the Invention]

However, the conventional manufacturing method has the following problems. First, in the roughly positioning step denoted by step P7 of Fig. 19 as shown in Figs. 21(a) and 21(b), the TFT panel 34 is dropped onto the CF panel 31. As a result, the TFT panel 34 and the CF panel 31 are easily deviated from each other.

[0009]

Second, in the roughly positioning step, the TFT panel 34 is pressed from the upside with the pressing member 43 shown in Fig. 20. However, at this time, since it is difficult to uniformly apply pressure to the entire surface of the wide TFT panel 34 due to the planarity of the pressing surface of the pressing member 43, the liquid crystal 33 is not uniformly diffused, or the gap between the TFT panel 34 and the CF panel 31 is not uniform, or a part of the sealing member is not sufficiently pressed to cause leakage.

[0010]

Third, when the liquid crystal and the non-cured sealing member come in contact with each other and the ultraviolet rays are irradiated to the contact area, the liquid crystal and the sealing member react with each other to cause contamination, thereby deteriorating a voltage holding rate of the liquid crystal display panel. The voltage holding rate is a value indicating to what extent the accumulated charges between both electrodes with the liquid crystal therebetween are not leaked and maintains the initial voltage from the first voltage application to the next voltage application when the voltage is intermittently applied to the liquid crystal panel, the value being expressed by $B/A \times 100$ shown in Figs. 25(a) and 25(b). "A" in the above-mentioned expression denotes an area of the hatched portion of Fig. 25(a) (time integral of a voltage held between the electrodes when no leakage occurs) and "B" is an area of the hatched portion of Fig. 25(b) (time integral of a voltage actually held between the electrodes).

[0011]

Figs. 23 and 24 are graphs illustrating relations between the voltage holding rate and the irradiation time of UV when the UV is irradiated to the sealing member after the liquid crystal and the non-cured sealing member come in contact with each other. As shown in Fig. 23, the voltage holding rate is deteriorated with the lapse of the

irradiation time of UV at any regions at the central region (25 mm from the sealing end) and in the vicinity of the sealing end (10 mm from the sealing end). Specifically, the deterioration of the voltage holding rate is remarkable in the vicinity of the sealing end, where the deterioration ranges 2 to 4%.

[0012]

Fig. 24 is a graph illustrating variation in voltage holding rate when the liquid crystal display panel is kept at a temperature of 80°C for 1,000 hours after the liquid crystal display panel is formed by sealing the liquid crystal using the same manufacturing method. The measurement position is the central portion (25 mm from the sealing end). As shown in Fig. 24, the deterioration in voltage holding rate is more remarkable.

[0013]

As shown in Figs. 23 and 24, in the conventional dropping injection method in which the sealing member is cured by irradiating the ultraviolet rays after the liquid crystal comes in contact with the sealing member, the voltage holding rate of the liquid crystal display panel is deteriorated. When the voltage holding rate is deteriorated, a sufficient driving voltage is not applied to the liquid crystal display panel. As a result, when the liquid crystal display panel is used as a display panel, the contrast of

the display panel is decreased.

[0014]

The present invention is contrived to solve the above-mentioned problems. It is an object of the present invention to provide a method of manufacturing a liquid crystal display device and an apparatus for manufacturing a liquid crystal display device, which can suppress decrease in voltage holding rate with a rough positioning accuracy and a uniform gap between panels.

[0015]

[Means for Solving the Problems]

The above-mentioned object can be accomplished by the following aspects of the present invention. According to Aspect 1 of the present invention, there is provided a method of manufacturing a liquid crystal display device, the method comprising the steps of: forming an adhesive member in a ring shape outside a display area on a first transparent panel; selectively irradiating ultraviolet rays onto the inner circumferential surface of the ring-shaped adhesive member and curing the irradiated area; dropping liquid crystal on the first transparent panel surrounded with the adhesive member; overlapping the first transparent panel and a second transparent panel with spacers therebetween in a decompressed atmosphere and sealing a space surrounded with the adhesive member between the first

transparent panel and the second transparent panel with the adhesive member; and positioning the first transparent panel and the second transparent panel, irradiating the ultraviolet rays onto the entire adhesive member, and curing the adhesive member. According to Aspect 2 of the present invention, there is provided a method of manufacturing a liquid crystal display device, the method comprising the steps of: forming a first adhesive member in a ring shape outside a display area on a first transparent panel; forming a second adhesive member in a ring shape outside the display area on a second transparent panel to correspond to the area where the first adhesive member; irradiating ultraviolet rays onto the first adhesive member and the second adhesive member and curing the surface layers thereof; dropping liquid crystal on the first transparent panel surrounded with the first adhesive member; overlapping the first transparent panel and the second transparent panel in a decompressed atmosphere and sealing a space surrounded with the first adhesive member and the second adhesive member between the first transparent panel and the second transparent panel with the adhesive members; and positioning the first transparent panel and the second transparent panel, irradiating the ultraviolet rays onto the first and second adhesive members, and curing the adhesive member, thereby fixing the first transparent panel and the second

transparent panel. According to Aspect 3, there is provided a method of manufacturing a liquid crystal display device, the method comprising the steps of: forming an adhesive member in a ring shape outside a display area on a first transparent panel; a dropping liquid crystal on the first transparent panel surrounded with the adhesive member; overlapping the first transparent panel and a second transparent panel with spacers therebetween in a decompressed atmosphere and sealing a space surrounded with the adhesive member between the first transparent panel and the second transparent panel with the adhesive member; and irradiating the ultraviolet rays onto the entire adhesive member and curing the adhesive member after positioning the first transparent panel and the second transparent panel and before the adhesive member comes in contact with the liquid crystal. According to Aspect 4 of the present invention, there is provided the method of manufacturing a liquid crystal display device according to any one of Aspects 1 to 3, wherein color filters or liquid crystal driving matrixes are formed in the display area on the first transparent panel and liquid crystal driving matrixes or color filters are formed in the display area on the second transparent panel. According to Aspect 5 of the present invention, there is provided the method of manufacturing a liquid crystal display device according to Aspect 3 or 4, wherein a

convex portion for reducing the diffusion speed of the liquid crystal is formed outside the display area on the first or second transparent panel and inside the area where the adhesive member is formed. According to Aspect 6 of the present invention, there is provided the method of manufacturing a liquid crystal display device according to Aspect 5, wherein The convex portion for reducing the diffusion speed of the liquid crystal is made of the same material as the color filters formed in the display area of the first or second transparent panel. According to Aspect 7 of the present invention, there is provided the method of manufacturing a liquid crystal display device according to any one of Aspects 1 to 6, wherein a film for capturing moving ions is formed on the first or second transparent panel inside and adjacent to the area where the adhesive member is formed. According to Aspect 8 of the present invention, there is provided the method of manufacturing a liquid crystal display device according to any one of Aspects 1 to 7, wherein the first transparent panel and the second transparent panel are overlapped with each other by inserting a spacer plate inserted between the first transparent panel and the second transparent panel such that a part of the first transparent panel and a part of the second transparent panel are in contact with each other and then removing the spacer plate and the gap

therebetween is sealed. According to Aspect 9 of the present invention, there is provided the method of manufacturing a liquid crystal display device according to any one of Aspects 1 to 7, wherein the first transparent panel has a plurality of holes or cut-out portions outside the ring-shaped adhesive member and the second transparent panel is overlapped with the first transparent panel by inserting support members into the holes or cut-out portions of the first transparent panel, laying the second transparent panel on the support members, and then descending the support members. According to Aspect 10 of the present invention, there is provided the method of manufacturing a liquid crystal display device according to any one of Aspects 1 to 9, wherein preliminary color filters are formed around the display area on the first or second transparent panel in accordance with the arrangement order of the color filters in the display area. According to Aspect 11 of the present invention, there is provided an apparatus for manufacturing a liquid crystal display device, the apparatus comprising: a process chamber in which a first transparent panel and a second transparent panel are overlapped with each other; and a gas introduction port which is disposed to face the first or second transparent panel laid in the process chamber and which sprays gas to the first or second transparent panel to press the panel.

According to Aspect 12 of the present invention there is provided the apparatus for manufacturing a liquid crystal display device according to Aspect 11, wherein the gas introduction port is a leak port for restoring the inner pressure of the process chamber to the atmospheric pressure.

[0016]

[Operation]

In the method of manufacturing a liquid crystal display device according to the present invention, first, the ultraviolet rays are selectively irradiated to the inner circumferential surface of the ring-shaped adhesive member formed on the first transparent panel in advance, thereby curing the irradiated area. As a result, even when the liquid crystal comes in contact with the adhesive member, the inner circumferential surface is cured by means of the irradiation of UV. Accordingly, when the first and second transparent panels are overlapped with each other and the liquid crystal is sealed in the gap with the adhesive member, it is possible to prevent the contamination of liquid crystal due to the reaction between the adhesive member and the liquid crystal. As a result, it is possible to suppress the decrease in voltage holding rate of the liquid crystal display device, thereby suppressing the decrease in contrast. In addition, since only the inner circumferential surface of the adhesive member is cured, the fixation between the

panels is stronger than the entire curing.

[0017]

The first transparent panel and the second transparent panel are overlapped with each other by forming the ring-shaped adhesive member on the first transparent panel and the second transparent panel, respectively, curing only the surface layers of the adhesive members, and then bringing the adhesive members into contact with each other. Since the adhesive members come in contact with each other, the cured surface layers are pressed and destroyed to reveal the non-cured portions. Therefore, the fixation between the first transparent panel and the second transparent panel becomes stronger by means of the irradiation of UV. Even when the cured surface layers are not destroyed, the fixation is stronger than that of the case where the transparent panel and the adhesive member are bonded to each other. In this way, even when the ultraviolet rays are irradiated onto the entire surfaces of the adhesive members and thus the surface layers are cured, the adhesion between the first and second transparent panels are not damaged.

[0018]

Second, after the first transparent panel and the second transparent panel are overlapped with the non-cured adhesive member and before the adhesive member and the liquid crystal come in contact with each other, the adhesive

member is cured by irradiating the ultraviolet rays onto the adhesive member. As a result, the first and second transparent panels can be surely bonded. In addition, the contamination of the liquid crystal caused by bringing the non-cured adhesive member into contact with the liquid crystal and irradiating the ultraviolet rays to the contact areas can be suppressed. Accordingly, it is possible to actively prevent the voltage holding rate of the liquid crystal display device from being decreased due to the contamination of the liquid crystal and thus to prevent the display contrast from being decreased.

[0019]

Third, the convex portions for delaying the diffusion speed of the liquid crystal are formed inside the adhesive member and outside the display area on the first or second transparent panel. Since the convex portions narrow the gap between the first and second transparent panel, the time for the liquid crystal to reach the adhesive member is increased. As a result, it is possible to easily irradiate the ultraviolet rays to the adhesive member to cur the adhesive member before the liquid crystal comes in contact with the adhesive member. Specifically, by making the convex portions out of the same material as the color filters formed in the display area of the first or second transparent panel, the convex portions can be formed at the

same time as forming the color filters in the display area, thereby simplifying the manufacturing process.

[0020]

Fourth, the film for capturing moving ions is formed on the first or second transparent panel inside and adjacent to the adhesive member. As a result, since the moving ions generated in the liquid crystal due to the reaction between the adhesive member and the liquid crystal is captured, it is possible to prevent the accumulated charges from being leaked by the moving ions. Accordingly, it is possible to more surely suppress the decrease in voltage holding rate of the liquid crystal display device.

[0021]

Fifth, when the first transparent panel and the second transparent panel are overlapped, the spacer plate is inserted between the first transparent panel and the second transparent panel such that a part of the first transparent panel and a part of the second transparent panel come in contact with each other and then the spacer plate is removed. Since the first transparent panel and the second transparent panel are overlapped more slowly than the conventional example where the panel is dropped, the rough positioning accuracy is improved. Since the impact is small, the destruction of the sealing member is not partially leaned. Accordingly, it is possible to improve the uniformity in gap

between the panels.

[0022]

Sixth, the first transparent panel has a plurality of holes or cut-out portions and the second transparent panel is overlapped with the first transparent panel by inserting the support members into the holes or cut-out portions, putting the second transparent panel on the support members, and dropping the support members. As a result, when the panels are positioned in advance and the speed for dropping the support members is delayed, the panels can be overlapped without positioning deviation, thereby improving the rough positioning accuracy. Since the positioning deviation at the time of bringing the panels into contact with the sealing member is small and the impact is small, the destruction of the sealing member is not deviated, thereby improving the uniformity in gap between the panels.

[0023]

Seventh, when the color filters are formed in the display area, the preliminary color filters are formed in the area around the display area of the liquid crystal display device in accordance with the arrangement order of the color filters. As a result, even when the first transparent panel is deviated from the display area of the second transparent panel at the time of overlapping the panels, the deviated end portion may be positioned at the

preliminary color filters. For this reason, the amount of adjustment for the positioning is small and thus it is easy to adjust the positioning. In addition, it is possible to avoid the damage on the adhesive member due to the great movement of the transparent panels for adjustment.

[0024]

Ninth, the apparatus for manufacturing a liquid crystal display device according to the present invention comprises the process chamber in which the first transparent panel is overlapped with the second transparent panel, the decompressing means for decompressing the process chamber, and the gas introduction port for spraying gas to the first transparent panel or the second transparent panel. The gas introduction port can be replaced with the leak port for restoring the decompressed pressure of the process chamber to the atmospheric pressure.

[0025]

Generally, since gas isotropically give pressure and is uniformly diffused onto the surfaces of the transparent panel, the pressure is uniform even when unevenness exists on the transparent panels. As a result, since the gap between the first and second transparent panel can be kept constant, a constant electric field is applied across the entire liquid crystal at the time of driving the liquid crystal display panel, thereby enhancing the uniformity in

display characteristic.

[0026]

[Embodiments]

Now, a method of and an apparatus for manufacturing a liquid crystal display device according to embodiments of the present invention will be described with reference the attached drawings.

(1) First Embodiment

Now, a method of manufacturing a liquid crystal display device according to a first embodiment of the present invention is described with reference to Figs. 1, 2(a), 2(b), 3(a), and 3(b). Fig. 2(b) is a cross-sectional view taken along Line A-A of Fig. 2(a).

[0027]

First, in step P1 of Fig. 1, elements required for manufacturing a liquid crystal display panel are formed on a transparent panel made of glass or the like. That is, for one liquid crystal display panel, two sheets of transparent panels made of glass of 10.4 inches are prepared and film formation/patterning for forming color filters of R (red), G (green), and B (blue) on a first transparent panel is repeated three times. Subsequently, a counter electrode made of a transparent ITO (Indium Tin Oxide) film is formed on the color filters and an alignment film is formed on the counter electrode, thereby forming a color filter panel

(hereinafter, referred to as "CF panel") 1.

[0028]

On the other hand, thin film transistors (TFT), drain bus lines, gate bus lines, and pixel electrodes are formed on a second transparent panel and an alignment film is formed thereon, thereby preparing a TFT panel 4. Next, in step P3, spacers SP are scattered on the surface of the TFT panel 4. The spacers SP serves to secure a space for enclosing liquid crystal between the CF panel 1 and the TFT panel 4. Plastic balls having a diameter of 5.0 μm and an adhesive property are used as the spacers SP. The adhesive property is given by performing a heating process after scattering the spacers. This is performed for the spacers SP not to move in the course of diffusing the liquid crystal and to facilitate the overlapping work.

[0029]

Next, in step P4, as shown in Fig. 2(a), the sealing member 2 made of a ultraviolet-curing adhesive (T-470 made by Nagasechiba) is formed in a ring shape on the surface of the CF panel 1 outwardly spaced by about 5 mm from a display area so as to surround a rectangular area for enclosing the liquid crystal. The sealing member 2 finally has a width of 2 mm by pressing the sealing member. Next, in step P5, as shown in Figs. 2(a) and (b), by selectively irradiating UV to the inner circumferential surface of the ring-shaped

sealing member 2 formed on the CF panel 1, the surface layer of the sealing member 2 in the irradiated area is semi-cured (hereinafter, this process is referred to as "pre-curing"). In this case, UV with a small intensity of about 500 mJ is irradiated such that only the surface layer of the sealing member in the irradiated area is cured.

[0030]

Next, in step P6, the liquid crystal is dropped onto the surface of the CF panel 1 in the area surrounded with the sealing member 2. Next, in step P7, the TFT panel 4 and the CF panel 1 are introduced into a bonding apparatus and the bonding apparatus is then decompressed into vacuum. Next, in step P8, the rough positioning is performed. That is, as shown in Fig. 3(a), the TFT panel 4 and the CF panel 1 are first opposed to each other in a decompressed atmosphere and as shown in Fig. 3(b), the CF panel 1 and the TFT panel 4 are overlapped with each other, thereby roughly positioning the panels. The degree of the rough positioning is about ±50 μm. By performing the rough positioning, the degree of adjustment at the time of the accurate positioning is reduced, damage on the sealing member 2 is prevented, and sealing property of the space for enclosing the liquid crystal between the CF panel 1 and the TFT panel 4 is secured.

[0031]

Subsequently, the panels are light pressed and the sealing member 2 is compressed, thereby enclosing the liquid crystal in the space between the panels. Next, in step P9, the panels subjected to the rough positioning is taken out in the atmosphere and then the accurate positioning is performed (hereinafter, this step is referred to as "accurate positioning"). Through this step, the dropped liquid crystal 3 is widely and uniformly diffused all over the area surrounded with the sealing member 2. Thereafter, in step P10, the sealing member 2 is completely cured by irradiating UV with great intensity of about 5000 mJ to the sealing member and the TFT panel 4 and the CF panel 1 are fixed, thereby completing the liquid crystal display panel. The optimum intensity of UV depends upon kinds of the adhesive.

[0032]

As described above, in the method of manufacturing a liquid crystal display device according to the first embodiment of the present invention, since the pre-curing is performed to the inner circumferential surface of the sealing member 2 in step P5 of Fig. 1 as shown in Fig. 2, the non-cured sealing member and the liquid crystal do not come in direct contact with each other even when the liquid crystal 3 reaches the non-cured sealing member 2 in step P10. The liquid crystal contamination which is a conventional

problem is generated because the non-cured sealing member and the liquid crystal come in direct contact with each other and UV is irradiated to the area. However, in the present embodiment, such contamination is not generated.

[0033]

This fact was confirmed from an experiment. The experiment result is now described with reference to Table 1. The voltage holding rate measured in the vicinity of the sealing member in the panel manufactured according to the present embodiment is greater than that of the case where the pre-curing is not performed. The measurement result is shown in Table 1.

[0034]

[Table 1]

| Pre-curing | Voltage holding rate (%) | Voltage holding rate (%) with the lapse of 1000 hours at 80°C |
|---|---|---|
| Yes | 98.0 | 97.0 |
| No | 96.0 | 94.0 |

[0035]

In Table 1, the used liquid crystal is ZLI-4792 (made by Mark) and the used alignment film is JALS-214 (made by JSR). According to the result shown in Table 1, the voltage holding rate of the panel not subjected to the pre-curing is 96.0% and the voltage holding rate of the panel subjected to

the pre-curing is 98.0%. The voltage holding rate with the lapse of 1000 hours at 80°C is 94.0% for the panel not subjected to the pre-curing and 97.0% for the panel subjected to the pre-curing. As described above, by performing the pre-curing, the decrease in voltage holding rate at the first time can be suppressed and the decrease in voltage holding rate after use for a long time can be also suppressed.

[0036]

As described above, in the method of manufacturing a liquid crystal display device according to the first embodiment of the present invention, since the decrease in voltage holding rate can be suppressed, it is possible to suppress the decrease in contrast of the liquid crystal display panel due to the decrease in voltage holding rate.

(2) Second Embodiment

Now, a method of manufacturing a liquid crystal display device according to a second embodiment of the present invention will be described with reference to Fig. 4. Steps P1 to P3 in Fig. 1 are similar to those of the first embodiment and thus descriptions thereof will be omitted.

[0037]

First, in step P4 of Fig. 1, the sealing member is formed on the surface of the TFT panel 4 as well as the CF panel 1. That is, shown in Fig. 4, a first sealing member

2B made of a ultraviolet-curing adhesive (T-470 made by Nagasechiba) is formed in a ring shape on the surface of the CF panel 1 so as to surround a rectangular area for enclosing the liquid crystal. A second sealing member having the same pattern as that of the first sealing member 2B is formed on the surface of the TFT substrate.

[0038]

Next, in the pre-curing step as step P5, the pre-curing is performed to the first sealing member 2B and the second sealing member 5. In the first embodiment, only the inner circumferential surface of the ring-shaped sealing material which is the area contacting the liquid crystal is selectively semi-cured. However, in the present embodiment, the entire surface of the sealing member is pre-cured, so that the surface layer 2C of the first sealing member 2 is semi-cured and the surface layer 5A of the second sealing member 5 is semi-cured similarly as shown in Fig. 4.

[0039]

Next, up to step P7, the same process as the first embodiment is carried out. In step P8, the TFT panel 4 and the CF panel 1 are overlapped and roughly positioned, the panels are lightly pressed, and the space between the TFT panel 4 and the CF panel 1 is sealed. At this time, as shown in Fig. 4, the formation area of the first sealing member 2B is matched with the formation area of the second

sealing member 5 through the rough positioning process.

[0040]

Thereafter, through the same processes as the first embodiment, the liquid crystal display panel is completed. As described above, in the method of manufacturing a liquid crystal display device according to the second embodiment of the present invention, the first sealing member 2B is formed on the surface of the CF panel 1 and the second sealing member 5 is also formed on the surface of the TFT panel 4. Then, after pre-curing both panels, the first and second sealing members 2B and 5 are positioned and then the TFT panel 4 and the CF panel 1 are compressed.

[0041]

For this reason, similar to the first embodiment, since the first sealing member 2B and the second sealing member 5 are pre-cured in advance in step P5 and thus are semi-cured, the non-cured sealing member does not directly contact the liquid crystal, thereby preventing the contamination of the liquid crystal. As a result, it is possible to suppress the decrease in voltage holding rate of the liquid crystal display device due to the liquid crystal contamination and thus to suppress the decrease in contrast at the time of display.

[0042]

In the present embodiment, unlike the first embodiment,

since the first sealing member 2B and the second sealing member 5 are bonded at the time of overlapping, the adhesive property between both panels is more improved than the liquid crystal display panel in which the sealing member is formed only on the CF panel 1. Even when the entire areas of the first and second sealing member 2B and 5 are semi-cured through the irradiation of UV, the adhesive property therebetween is not decreased.

[0043]

Similar to the first embodiment, UV rays may be selectively irradiated to the inner circumferential surfaces of the first and second sealing members 2B and 5 and only the irradiated area may be semi-cured. By performing the UV pre-curing, it is possible to form the sealing member with high viscosity using a material (having good applicability) with low viscosity. In addition, it is possible to reduce the damage on the sealing member due to the atmospheric pressure when the panels are restored to the atmosphere.

[0044]

(3) Third Embodiment

Now, a method of manufacturing a liquid crystal display device according to a third embodiment of the present invention will be described with reference to Figs. 5(a) and 5(b). Fig. 5(a) is a cross-sectional view, Fig. 5(b) is a plan view, where Fig. 5(a) is a cross-sectional view taken

along Line B-B of the Fig. 5(b). The same elements as the first and second embodiments are not described for the purpose of avoiding repetition.

[0045]

First, in the process of forming elements required for forming the liquid crystal display panel on the transparent panel in step P1 of Fig. 1, the TFT panel 4 is formed using the same processes as the first embodiment but when patterning and forming the color filters in the display area of the CF panel 1, convex portions 6A and 6B made of the same material as the ring-shaped color filters are patterned and formed outside the display area and inside the formation area of the sealing member.

[0046]

At this time, the formation area of the convex portions 6A and 6B is protruded higher than the peripheral area thereof. When a transparent electrode 7 or an alignment film 8 made of an ITO film is formed thereon, the convex portions 9A and 9B are formed shown in Fig. 5(a), thereby narrowing the gap therebetween. Thereafter, the same processes as the first embodiment are carried out. However, the pre-curing of step P5 may be omitted.

[0047]

The contamination of liquid crystal is caused because the liquid crystal comes in direct contact with the non-

cured adhesive and the UV is irradiated to the contact area. Even by using a dropping injection method, it takes several minutes (five minutes) for the liquid crystal to completely and uniformly diffuse into the TFT liquid crystal panel with 10 inches. As a result, By taking out the panel from the bonding chamber and irradiating UV to the sealing member as early as possible before the liquid crystal reaches the sealing member, it is possible to suppress the decrease in voltage holding rate due to the contamination of liquid crystal. However, in the present embodiment, by providing the convex portions 9A and 9B between the center portion of the transparent panel and the sealing member to narrow the gap and delaying the diffusion of the liquid crystal, it is possible to more surely prevent the non-cured sealing member from contacting the liquid crystal.

[0048]

The comparison result of an example where the UV is irradiated before the liquid crystal and the sealing member come in contact with each other and an example where the UV is irradiated after the liquid crystal and the sealing member contact each other by using a test panel of 14 inches is shown in Table 2.

[0049]

[Table 2]

| | Voltage holding rate (%) | Voltage holding rate (%) with the lapse of 1000 hours at 80°C |
|---|---|---|
| UV irradiation before liquid crystal contact sealing material | 98 | 98 |
| UV irradiation after liquid crystal contact sealing material | 96 | 94 |

[0050]

In Table 2, the used liquid crystal is ZLI-4792 (made by Mark) and the used alignment film is JALS-214 (made by JSR). According to the result shown in Table 2, the voltage holding rate is 98% for the panel subjected to the UV irradiation before the liquid crystal contacts the sealing member and the voltage holding rate is 96% for the panel subjected to the UV irradiation after the liquid crystal contacts the sealing member. The voltage holding rate with the lapse of 1000 hours at 80°C is 98% for the panel subjected to the UV irradiation before contact and 94.0% for the panel subjected to the UV irradiation after contact. Accordingly, by performing the UV irradiation before the liquid crystal contacts the sealing member, it can be seen that the decrease in voltage holding rate can be suppressed.

[0051]

The method of manufacturing a liquid crystal display device according to the third embodiment of the present invention uses this fact. That is, convex portions 6A and 6B made of the same material as the color filters are patterned and formed between the display area and the formation area of the sealing member on the CF panel 1. As the convex portions 6A and 6B, at least one layer of R, G, and B may be formed. Subsequently, the transparent electrode 7 and the alignment film 8 are sequentially formed on the convex portions 6A and 6B, thereby forming the convex portions 9A and 9B having a greater height.

[0052]

The gap between the CF panel 1 and the TFT panel 4 in the area where the convex portions 9A and 9B are formed is narrowed as shown in Fig. 5(a), thereby increasing the time taken for the liquid crystal 3 diffused by compression to reach the sealing member 2. Accordingly, before the liquid crystal 3 reaches the sealing member 2, UV can be irradiated to the sealing member with a time margin to cure the sealing member.

[0053]

As a result, the decrease in voltage holding rate of the liquid crystal display device can be suppressed, thereby suppressing the decrease in contrast at the time of display. In addition, the pattern of the convex portions made of the

color filters may have a ring shape as shown in Figs. 5(a) and 5(b). However, the present invention is not limited to the ring-shaped pattern, but the convex portions 9C having island-shaped patterns, for example, as shown in Fig. 6 may be formed. This case exhibits the same effect as the case where the convex portions 9A and 9B shown in Figs. 5(a) and 5(b).

[0054]

(4) Fourth Embodiment

Now, a method of manufacturing a liquid crystal display device according to a fourth embodiment of the present invention will be described with reference to Figs. 7(a), 7(b), 8(a), and 8(b). Figs. 7(a), 7(b), and 8(a) are cross-sectional views and Fig. 8(b) is a plan view. Fig. 8(a) is a cross-sectional view taken along Line C-C of Fig. 8(b). The same elements as the first, or second, or third embodiment will be not described for the purpose of avoiding repetition.

[0055]

First, up to steps P1 to P7 of Fig. 1, the same processes as the first embodiment are carried out. In the rough positioning process of step P8, as shown in Fig. 7(a), a spacer plate 11 having a thickness of 2 mm is interposed between the CF panel 1 and the TFT panel 4 such that one side of the TFT panel 4 contacts one side of the CF panel 1

mounted on the stage ST. For example, as shown in Figs. 8(a) and 8(b), the spacer plate 11 is inserted into one place between the CF panel 1 and the TFT panel 4 overlapped with each other.

[0056]

Guide rods 10 are disposed at four corners of the respective panels 1 and 4 such that positional deviation does not occur. Next, when the spacer plate 11 is horizontally taken out, the TFT panel 4 is dropped onto and overlapped with the CF panel 1 with its own weight as shown in Fig. 7(b). At this time, since the four corners of the TFT panel 4 is provided with the guide rods 10, the TFT panel 4 is not pulled an deviated in position by the spacer plate 11. The subsequent process are equal to those of the first embodiment and thus descriptions thereof will be omitted.

[0057]

As described above, in the method of manufacturing a liquid crystal display device according to the fourth embodiment, by inserting the spacer plate 11 such that one side of the TFT panel 4 and one side of the CF panel 1 come in contact with each other and then taking out the spacer plate, the CF panel 1 and the TFT panel 1 are overlapped with each other. Conventionally, the liquid crystal is rapidly compressed by opposing the TFT panel to the CF panel

and then freely dropping the TFT panel, but in the present embodiment, at least one side of the TFT panel 4 and one side of the CF panel 1 come in contact with each other, so that the TFT panel is more slowly dropped. As a result, a great pressure is not applied to the sealing member 2 formed on the CF panel 1 and thus the destruction of the sealing member 2 is not deviated. Therefore, the gap between the CF panel 1 and the TFT panel 4 is uniform.

[0058]

In the present embodiment, the TFT panel 4 is overlapped with the CF panel 4 by inserting the spacer plate 11 into only one place between the CF panel 1 and the TFT panel 4 and then taking out the spacer plate. However, the present invention is not limited to this, but as shown in Figs. 8(c) and 8(d), the same effect is obtained in a case where two spacer plates 11A and 11B are inserted between the CF panel 1 and the TFT panel 4 to support two places. In addition, as shown in Figs. 9(a) and 9(b), the same effect is obtained in a case where three spacer plates 11A, 11B, and 11C are inserted between the panels to support three places. If at least one side of the CF panel 1 and one side of the TFT panel 4 contact each other, it is enough. Figs. 8(c) and 9(a) are cross-sectional views and Figs. 8(d) and 9(b) are plan views, where Fig. 8(c) is a cross-sectional view taken along Line D-D of Fig. 8(d) and Fig. 9(b) is a

cross-sectional view taken along Line E-E of Fig. 9(a).

[0059]

By applying the method according to the present embodiment to a plurality of liquid crystal display panels, it is possible to mount the TFT panels on the CF panels for a short time. Now, this will be described with reference to Figs. 10 and 11. That is, as shown in Fig. 10, the CF panels and the TFT panels are alternately stacked and the guide rods 10 are disposed around the stacked panels. Fig. 11 is a side view of this state. From the bottom, the TFT panel 4C, the CF panel 1C, the TFT panel 4B, the CF panel 1B, the TFT panel 4A, and the CF panel 1A are sequentially stacked the spacer plates 11C, 11B, and 11A are inserted therebetween, respectively.

[0060]

Only by horizontally taking out the respective spacer plates 11A, 11B, and 11C, a plurality of TFT panels corresponding to a plurality of liquid crystal display panels can be mounted on the corresponding CF panels with ease for a short time.

(5) Fifth Embodiment

Now, a method of manufacturing a liquid crystal display device according to a fifth embodiment of the present invention will be described with reference to Figs. 12(a) to 12(c). The same elements as those of the first to fourth

embodiments will not be described for the purpose of avoiding repetition.

[0061]

First, in the process of forming elements for forming a liquid crystal display panel on the transparent panel in step P1 of Fig. 1, the TFT panel 4 is formed through the same processes as the first embodiment, but a plurality of guide holes 1H are formed at the four corners of the CF panel 1 by using a super steel drill or a carbon dioxide laser. Next, in steps P2 to P7 of Fig. 1, the same processes as the first embodiment are carried out. Then, in the rough positioning process of step P8 of Fig. 1, as shown in Fig. 12(a), support rods 12A and 12B are inserted into the guide holes 1H formed at the four corners of the CF panel 1 on the stage ST and the TFT panel 4 is placed thereon. In this step, the TFT panel 4 and the CF panel 1 are apart from each other with a gap of about 2 mm. Only two support rods 12A and 12B are shown and two support rods are omitted in Fig. 12(a).

[0062]

Thereafter, as shown in Figs. 12(b) and 12(c), the support rods 12A and 12B are slowly lowered, thereby overlapping the TFT panel 4 with the CF panel 1. The processes after step P9 of Fig. 1 are equal to the first embodiment and descriptions thereof thus are omitted. As

described above, in the method of manufacturing a liquid crystal display device according to the fifth embodiment of the present invention, by forming the guide holes 1H at four corners of the CF panel 1, inserting the support rods 12A and 12B into the guide holes, placing the TFT panel 4 on the support rods 12A and 12B, and slowly lowering the support rods 12A and 12B to overlap the TFT panel 4 with the CF panel 1, the rough positioning process is carried out.

[0063]

For this reason, since the panels can be overlapped without positional deviation by performing the positioning process in advance and reducing the speed for lowering the support mechanism, the rough positioning accuracy is improved. In addition, since the deviation and the impact at the time of bringing the panel into contact with the sealing member 2 are small, the destruction of the sealing member 2 is not deviated, thereby improving the uniformity in gap between the panels. Similar to the present embodiment, in a method of overlapping the TFT panel 4 with the CF panel 1 by forming cut-out portions 1K at the four corners of the CF panel 1 as shown in Figs. 13(a) and 13(b) instead of the guide holes 1H, inserting the support rods 12A, 12B, 12C, and 12D into the cut-out portions 1K, placing the TFT panel 4 on the four support rods 12A, 12B, 12C, and 12D, and lowering the support rods 12A, 12B, 12C, and 12D,

the TFT panel 4 can be slowly lowered onto the CF panel 1 similarly to the method using the guide holes 1H according to the present embodiment. As a result, the same effect as the present embodiment can be obtained.

[0064]

Glass capsules which are used as a plastic filler for engineering may be inserted between the TFT panel and the CF panel and may be used as the spacer plate. Since the glass capsules are destroyed by means of the pressing force at the time of compressing the panels and are narrowed, there occurs no problem with the gap control. In addition, since the fractures of the glass capsules remaining on the panel are transparent, there occurs no problem with display.

[0065]

(6) Sixth Embodiment

Now, a method of manufacturing a liquid crystal display device according to a sixth embodiment of the present invention will be described with reference to the figures. The same elements as the first to fifth embodiments will not be described for the purpose of avoiding repetition. First, in steps P1 to P3 of Fig. 1, the same processes as the first embodiment are carried out. In the process of forming the sealing member in step P4, unlike the first to fifth embodiments, a film 13A (AP-400 made by Tohre) made of a silane coupling material is formed in a ring shape in the

area in which the sealing member is formed on the surface of the CF panel 1, as an example of a film for capturing moving ions.

[0066]

Similarly, a film 13B made of the same silane coupling material is formed in the area in which the sealing member should be compressed later on the surface of the TFT panel 4. The films 13A and 13B are formed using a printing method and a heating process is performed at a temperature 300°C for 30 minutes for curing. Next, the sealing member 2 made of a UV-curing adhesive (T0470 made by Nagasechiba) is formed in a ring shape on the film 13A made of the silane coupling material and formed on the CF panel 1.

[0067]

Thereafter, in steps P5 to P10 of Fig. 1, a liquid crystal display panel having a sectional shape shown in Fig. 14 is completed through the same processes as the first embodiment. In the rough positioning process of step P8, at least the film 13B made of the silane coupling material on the TFT panel 4 exists inside the sealing member 2. As described above, in the method of manufacturing a liquid crystal display device according to the sixth embodiment of the present invention, as shown in Fig. 14, the films 13A and 13B made of the silane coupling material as the film form capturing the moving ions are formed in the formation

area of the sealing member 2 inside the ring-shaped sealing member 2.

[0068]

As a result, since the moving ions existing in the vicinity of the sealing member 2 are captured by the films 13A and 13B made of the silane coupling material, the leakage of the accumulated charges due to the moving ions can be prevented. Accordingly, it is possible to suppress the decrease in voltage holding rate and thus to suppress the decrease in contrast of the liquid crystal display device at the time of display.

[0069]

The fact that the decrease in voltage holding rate can be suppressed by forming the film made of the silane coupling material in the vicinity of the formation area of the sealing member was confirmed from the experiment executed by the inventors. Now, the experimental result will be described. The comparison result of the voltage holding rate of the liquid crystal display panel in which the film made of the silane coupling material (AP-400 made by Tohre) formed in the vicinity of the formation area of the sealing member and the voltage holding rate of the conventional liquid crystal display panel not using the film is shown in Table 3.

[0070]

[Table 3]

| | Voltage holding rate (%) | Voltage holding rate (%) with the lapse of 1000 hours at 80°C |
|---|---|---|
| AP-400 exist | 97 | 97 |
| AP-400 not exist | 96 | 94 |

[0071]

In Table 3, the used liquid crystal is ZLI-4792 (made by Mark) and the used alignment film is JALS-214 (made by JSR). According to the result shown in Table 3, the voltage holding rate is 97% for the liquid crystal display panel in which the film made of the silane coupling material is formed in the vicinity of the formation area of the sealing member and 96% for the conventional liquid crystal display panel not having the film made of the silane coupling material. The voltage holding rate with the lapse of 1000 hours at 80°C is 97% for the liquid crystal display panel having the film made of the silane coupling material and 94.0% for the conventional liquid crystal display panel not having the film. Accordingly, in the liquid crystal display panel in which the film made of the silane coupling material is formed in the vicinity of the formation area of the sealing member, it can be seen that the decrease in voltage holding rate can be suppressed.

[0072]

In the present embodiment, the film made of the silane coupling material is used as an example of the film for capturing the moving ions. However, the present invention is not limited to the embodiment, but may be applied to any film capable of capturing the moving ions only if the film does not contaminate the liquid crystal.

(7) Seventh Embodiment

Now, an apparatus for manufacturing a liquid crystal display device according to a seventh embodiment of the present invention will be described with reference to the figures. The apparatus is a bonding apparatus used for the vacuum exhaust process of step P7 and the rough positioning process of step P8 in Fig. 1. The apparatus is used for the processes of receiving the CF panel and the TFT panel, decompressing the inside, overlapping the panels to perform the rough positioning, and enclosing the liquid crystal in the gap between the panels.

[0073]

The apparatus for manufacturing a liquid crystal display device according to the present embodiment comprises, as shown in Fig. 15, a process chamber 20, an exhaust valve 21, an exhaust port 22, a leak valve 23, a leak port 24, and a stand ST. The process chamber 20 is a chamber in which the CF panel 1 and the TFT panel 4 are bonded. The exhaust valve 21 constitutes a part of the decompressing means and

is provided between a vacuum pump not shown and the exhaust port 21. By opening the exhaust valve 21 and exhausting the process chamber through the exhaust port 22, the process chamber 20 is decompressed.

[0074]

The leak valve 23 is provided between the leak port 24 and a gas bombe not shown but receiving inert gas or the like. By opening the leak valve 23, the gas discharged from the gas bombe is introduced into the process chamber 20 through the leak port 24. The leak valve 23 and the leak port 24 constitute the leak means. The gas bombe receiving inert gas or the like may be not connected to the leak valve 23 and the leaking process may be performed using the atmosphere.

[0075]

A method of manufacturing a liquid crystal display device by using the above-mentioned apparatus will be described. Similar to the first embodiment, the processes of steps P1 to P6 shown in Fig. 1 are performed and in step P7 shown in Fig. 1, the TFT panel 4 and the CF panel 1 in which the liquid crystal 3 is dropped inside the ring-shaped sealing member 2 are introduced into the process chamber 20. The CF panel 1 is mounted on the stand ST.

[0076]

Next, by opening the exhaust valve 21, the process

chamber 20 is exhausted by means of a vacuum pump not shown. Here, by performing the exhaust process for five minutes, the degree of vacuum in the process chamber 20 reaches 5 mTorr. Thereafter, in the rough positioning process of step P8 shown in Fig. 1, the TFT panel 4 and the CF panel 1 are overlapped with the sealing member 2 and the rough positioning is performed in a decompressed state. Subsequently, the pressing process is performed.

[0077]

In the pressing process, the leak valve 23 is instantaneously opened and nitrogen gas, etc. is ejected to the TFT panel 4 from the leak port 24. By ejecting the nitrogen gas, the TFT panel 4 is pressed to the CF panel 1. Gas isotropically applies pressure to a target and is diffused all over the surface of the TFT panel 4. Therefore, when the gas is sprayed to the upper surface of the TFT panel 4, the pressure applied to the TFT panel 4 is almost uniform. Accordingly, since the TFT panel 4 is pressed with a homogeneous force, the gap between the panels 1 and 4 is uniform. As a result, when a driving voltage is applied to the liquid crystal display panel, the electric field applied to the liquid crystal between the panels is homogeneous, thereby improving the display characteristic.

[0078]

Similarly, a bonding apparatus shown in Fig. 16 can be

considered as the bonding apparatus for performing the pressing process using gas. This apparatus is different from the apparatus shown in Fig. 15, in that leak holes 24 are formed in the formation area of the sealing member 2 of the liquid crystal display panel. In order to press the TFT panel 4 overlapped on the CF panel 1 by using the bonding apparatus shown in Fig. 16, the leak valve 23 is opened and the gas supplied from a gas bombe not shown is sprayed from the leak holes 24, similar to the bonding apparatus shown in Fig. In the bonding apparatus, since the leak holes 24 are formed along the formation area of the sealing member 2, the gas is sprayed only in the formation area of the sealing member 2.

[0079]

At the time of pressing the TFT panel 4 and the CF panel 1, it is important to uniformly press the sealing member 2. According to the bonding apparatus, since the gas is sprayed along the sealing member to uniformly press the sealing member 2, it is possible to make the gap between the panels 1 and 4 uniform, similar to the apparatus shown in Fig. 15.

(8) Eighth Embodiment

Now, An apparatus for manufacturing a liquid crystal display device according to an eighth embodiment of the present invention will be described with reference to Fig.

17. The apparatus is a bonding apparatus used for the vacuum exhaust process of step P7 and the rough positioning process of step P8 in Fig. 1, similar to the apparatus for manufacturing a liquid crystal display device according to the seventh embodiment. Here, the CF panel and the TFT panel are introduced into the bonding apparatus, the bonding apparatus is exhausted, and the panels are roughly positioned.

[0080]

The apparatus for manufacturing a liquid crystal display device according to the present embodiment comprises a process chamber 20, an exhaust valve 21, an exhaust port 22, a first leak valve 23A, a second leak valve 23B, a first leak port 24A, a second leak port 24B, a pressing plate 25, and a stand ST. The process chamber 20 is a chamber for performing the bonding process. The exhaust valve 21 is provided between a vacuum valve not shown and the exhaust port 21. By opening the exhaust valve 21, the gas in the process chamber 20 is discharged through the exhaust port 22, thereby decompressing the process chamber.

[0081]

The first leak valve 23A is provided outside the leak port 24A. By opening the first leak valve 23A, gas supplied from the gas bombe not shown is sprayed to the upper surface of the pressing plate. The pressing plate 25 is supported

on the stand ST by a bellows VS expandable and is isolated from the inside of the process chamber 20. When the gas is sprayed, the bellows VS is expanded to press the upper surface of the TFT panel mounted on the stand ST.

[0082]

The second leak valve 23B is provided outside the leak port 24B. By opening the second leak valve 23B, the air outside the bonding apparatus is introduced into the process chamber 20. A method of manufacturing a liquid crystal display device using the apparatus for manufacturing a liquid crystal display device will be now described. Similar to the first embodiment, the processes of steps P1 to P6 in Fig. 1 are carried out. In step P7 of Fig. 1, the CF panel 1 and the TFT panel 4 on which the sealing member 2 is formed and the liquid crystal 3 is dropped are introduced into the process chamber 20. The CF panel 1 is mounted on the stand ST.

[0083]

By disposing the TFT panel 4 above the CF panel to oppose the CF panel 1 and opening the exhaust valve 21, the process chamber 20 is exhausted into vacuum by a vacuum pump not shown. By performing the exhaust process for five minutes, the degree of vacuum reaches to 5 mTorr. Thereafter, in the rough positioning process of step P8 shown in Fig. 1, the TFT panel 4 is disposed on the CF panel

1 in vacuum to closely oppose them to each other and then the opposed panels are pressed.

[0084]

In the pressing process, by instantaneously opening the first leak valve 23, nitrogen gas, etc. supplied from a gas pump not shown is sprayed to the TFT panel 4 from the leak port 24 with a uniform pressure and the TFT panel 4 is pressed by the pressing plate 25. Accordingly, the TFT panel 4 is pressed onto the CF panel 1. In the pressing process, the pressing plate 25 is pressed using the gas and the TFT panel 4 is pressed by the pressing plate 25. Generally, gas has an isotropic characteristic. Accordingly, by spraying the gas to the upper surface of the pressing plate 25, the gas is diffused all over the surface of the pressing plate 25 and the pressure of the gas is uniform. Accordingly, since the TFT panel 4 is pressed with the uniform pressure, it is possible to press the TFT panel 4 and the CF panel 1 with the uniform force, unlike the conventional case.

[0085]

As a result, since the liquid crystal can be uniformly diffused between the panels, the gap between the panels 1 and 4 can be kept uniform, thereby improving the display characteristic.

(9) Ninth Embodiment

Now, a method of manufacturing a liquid crystal display device according to a ninth embodiment of the present invention will be described with reference to Figs. 18(a) and 18(b). The same elements as the first to eighth embodiments will not be described for the purpose of avoiding repetition.

[0086]

First, in step P1 shown in Fig. 1, in forming elements required for forming a liquid crystal display panel on a transparent panel made of glass or the like, the process for the TFT panel 4 is similar to the first embodiment. However, in forming color filters on the CF panel 1, preliminary color filters are formed in accordance with the arrangement order of the color filters in the display area CR in a peripheral area of the display area CR at the same time as forming the color filters in the display area CR of the liquid crystal display device as shown in Fig. 18(b). The subsequent process are similar to the first embodiment and thus description thereof is omitted.

[0087]

In the method of manufacturing a liquid crystal display device according to the ninth embodiment of the present invention, as shown in Figs. 18(a) and 18(b), since the preliminary color filters are formed in accordance with the arrangement order of the color filters in the display area

CR in a peripheral area of the display area CR. Accordingly, even when positional deviation occurs in overlapping the TFT panel 4 with the CF panel 1, the end portions departing from the display area CR can be set to the positions of the preliminary color filters CM. As a result, the degree of adjustment for positioning is small and the adjustment is easily performed. In addition, it is possible to prevent damage on the adhesive due to the great movement of the panels for adjustment.

[0088]

[Advantages]

As described above, in the method of manufacturing a liquid crystal display device according to the present invention, the ultraviolet rays are selectively irradiated to the inner circumferential surface of the ring-shaped adhesive member formed on the first transparent panel in advance, thereby curing the irradiated area. As a result, it is possible to prevent the contamination of liquid crystal due to the reaction between the adhesive member and the liquid crystal sealed in the gap between the first and second transparent panels. Accordingly, it is possible to suppress the decrease in voltage holding rate of the liquid crystal display device, thereby suppressing the decrease in contrast. In addition, since only the inner circumferential surface of the adhesive member is cured, the fixation

between the panels is stronger than the case where the entire surface is cured.

[0089]

The first transparent panel and the second transparent panel are overlapped with each other by forming the ring-shaped adhesive member on the first transparent panel and the second transparent panel, respectively, curing only the surface layers of the adhesive members, and then bringing the adhesive members into contact with each other. since the adhesive members come in contact with each other, the fixation of the first transparent panel and the second transparent panel becomes stronger even when only the surface layers are cured.

[0090]

In addition, after the first transparent panel and the second transparent panel are overlapped with the non-cured adhesive member and before the adhesive member and the liquid crystal come in contact with each other, the adhesive member is cured by irradiating the ultraviolet rays onto the adhesive member. As a result, the first and second transparent panels can be surely fixed to each other. In addition, the conventional contamination of the liquid crystal caused by bringing the non-cured adhesive member into contact with the liquid crystal and irradiating the ultraviolet rays to the contact areas can be suppressed.

Accordingly, it is possible to actively prevent the voltage holding rate of the liquid crystal display device from being decreased due to the contamination of the liquid crystal and thus to prevent the display contrast from being decreased.

[0091]

Specifically, since the convex portions for delaying the diffusion speed of the liquid crystal are formed inside the adhesive member and outside the display area on the first or second transparent panel, it is possible to easily irradiate the ultraviolet rays to the adhesive member to cur the adhesive member with the margin of time before the liquid crystal comes in contact with the adhesive member. Furthermore, the film for capturing the moving ions is formed on the first or second transparent panel inside and adjacent to the adhesive member.

[0092]

As a result, since the moving ions generated in the liquid crystal due to the reaction between the adhesive member and the liquid crystal is captured, it is possible to prevent the accumulated charges from being leaked by the moving ions. Accordingly, it is possible to more surely suppress the decrease in voltage holding rate of the liquid crystal display device. In addition, when the first transparent panel and the second transparent panel are overlapped, the spacer plate is inserted between the first

transparent panel and the second transparent panel such that a part of the first transparent panel and a part of the second transparent panel come in contact with each other and then the spacer plate is removed.

[0093]

The first transparent panel has a plurality of holes or cut-out portions and the second transparent panel is overlapped with the first transparent panel by allowing the support members to pass through the holes or cut-out portions, laying the second transparent panel on the support members, and then descending the support members. As a result, the rough positioning accuracy is improved and the uniformity in gap between the panels is improved.

[0094]

Further, when the color filters are formed in the display area, the preliminary color filters are formed around the display area of the liquid crystal display device in accordance with the arrangement order of the color filters in the display area. As a result, the degree of adjustment for position is small and the adjustment is easy. In addition, it is possible to prevent damage of the adhesive member due to great movement of the transparent panels for adjustment.

[0095]

In the apparatus for manufacturing a liquid crystal

display device according to the present invention, there is provided the process chamber in which the first transparent panel and the second transparent panel are overlapped, the decompressing means for decompressing the process chamber, and the gas introduction port for ejecting gas to the surface of the first transparent panel or the second transparent panel. The gas introduction port may be replaced with the leak port for restoring the decompressed pressure of the process chamber to the atmospheric pressure.

[0096]

As a result, since the pressing force becomes uniform and thus the gap between the first and second transparent panels becomes uniform, a constant electric field is applied to the entire liquid crystal at the time of driving the liquid crystal display panel, thereby enhancing the uniformity in display characteristic.

[Brief Description of the Drawings]

[Fig. 1]

Fig. 1 is a flowchart illustrating a method of manufacturing a liquid crystal display device according to a first embodiment of the present invention.

[Fig. 2]

Fig. 2 is a schematic view (first view) illustrating the method of manufacturing a liquid crystal display device

according to the first embodiment of the present invention.

[Fig. 3]

Fig. 3 is a schematic view (second view) illustrating the method of manufacturing a liquid crystal display device according to the first embodiment of the present invention.

[Fig. 4]

Fig. 4 is a schematic view illustrating a method of manufacturing a liquid crystal display device according to a second embodiment of the present invention.

[Fig. 5]

Fig. 5 is a schematic view (first view) illustrating a method of manufacturing a liquid crystal display device according to a third embodiment of the present invention.

[Fig. 6]

Fig. 6 is a schematic view (second view) illustrating the method of manufacturing a liquid crystal display device according to the third embodiment of the present invention.

[Fig. 7]

Fig. 7 is a cross-sectional view (first view) illustrating a method of manufacturing a liquid crystal display device according to a fourth embodiment of the present invention.

[Fig. 8]

Fig. 8 is a top view (first view) illustrating the method of manufacturing a liquid crystal display device

according to the fourth embodiment of the present invention.

[Fig. 9]

Fig. 9 is a top view (second view) illustrating the method of manufacturing a liquid crystal display device according to the fourth embodiment of the present invention.

[Fig. 10]

Fig. 10 is a perspective view illustrating the method of manufacturing a liquid crystal display device according to the fourth embodiment of the present invention.

[Fig. 11]

Fig. 11 is a cross-sectional view (second view) illustrating the method of manufacturing a liquid crystal display device according to the fourth embodiment of the present invention.

[Fig. 12]

Fig. 12 is a cross-sectional view illustrating a method of manufacturing a liquid crystal display device according to a fifth embodiment of the present invention.

[Fig. 13]

Fig. 13 is a schematic view illustrating the method of manufacturing a liquid crystal display device according to the fifth embodiment of the present invention.

[Fig. 14]

Fig. 14 is a cross-sectional view illustrating a method of manufacturing a liquid crystal display device according

to a sixth embodiment of the present invention.

[Fig. 15]

Fig. 15 is a schematic view (first view) illustrating an apparatus for manufacturing a liquid crystal display device according to a seventh embodiment of the present invention.

[Fig. 16]

Fig. 16 is a schematic view (second view) illustrating the apparatus of manufacturing a liquid crystal display device according to the seventh embodiment of the present invention.

[Fig. 17]

Fig. 12 is a cross-sectional view illustrating a method of manufacturing a liquid crystal display device according to an eighth embodiment of the present invention.

[Fig. 18]

Fig. 12 is a schematic view illustrating a method of manufacturing a liquid crystal display device according to a ninth embodiment of the present invention.

[Fig. 19]

Fig. 19 is a flowchart illustrating a conventional method of manufacturing a liquid crystal display device.

[Fig. 20]

Fig. 20 is a cross-sectional view illustrating a conventional apparatus for manufacturing a liquid crystal

display device.

[Fig. 21]

Fig. 21 is a schematic view (first view) illustrating the conventional method of manufacturing a liquid crystal display device.

[Fig. 22]

Fig. 22 is a schematic view (second view) illustrating the conventional method of manufacturing a liquid crystal display device.

[Fig. 23]

Fig. 23 is a graph (first view) illustrating a problem of a conventional example.

[Fig. 24]

Fig. 24 is a graph (second view) illustrating a problem of a conventional example.

[Fig. 25]

Fig. 25 is a graph illustrating a voltage holding rate of a liquid crystal display panel.

[Reference Numerals]

1: CF PANEL (FIRST TRANSPARENT PANEL)

1A, 1B, 1C: CF PANEL

1H: GUIDE HOLE

1K: CUT-OUT PORTION

2: SEALING MEMBER (ADHESIVE MEMBER)

2A: INNER CIRCUMFERENTIAL SURFACE OF SEALING MEMBER

2B: FIRST SEALING MEMBER (FIRST ADHESIVE MEMBER)

2C: SEMI-CURED SEALING MEMBER

3: LIQUID CRYSTAL

4: TFT PANEL (SECOND TRANSPARENT PANEL)

4a, 4b, 4c: TFT PANEL

5: SECOND SEALING MEMBER (SECOND ADHESIVE MEMBER)

5a: SEMI-CURED SEALING MEMBER

6A, 6B, 9A, 9B, 9C: CONVEX PORTION

7: TRANSPARENT ELECTRODE

8: ALIGNMENT FILM

11, 11A, 11B, 11C: SPACER PLATE

12A, 12B, 12C, 12D: SUPPORT ROD

13A, 13B: FILM MADE OF SILANE COUPLING AGENT (FILM FOR CAPTURING MOVING IONS)

20: PROCESS CHAMBER

21: EXHAUST VALVE

22: EXHAUST PORT

23: LEAK VALVE

23A: FIRST LEAK VALVE

23B: SECOND LEAK VALVE

24, 24A: LEAK PORT

24B: SECOND LEAK PORT

25: PRESSING PLATE

CR: DISPLAY AREA

CM: PRELIMINARY COLOR FILTER

ST: STAGE

SP: SPACER

VS: BELLOWS